

Description

MORTAR TILE AND METHOD FOR PRODUCTION THEREOF

Technical Field

The present invention relates to a mortar tile which is formed in a tile shape using mortar as a raw material and a manufacturing method thereof.

Background of the Invention

Conventionally, a mortar has been popularly used as a wall material since the mortar possesses respiratory property, water resistant property and weatherability.

On the other hand, in recent years, the air pollution caused by volatile harmful substances such as formaldehyde and formalin has become a social problem.

Accordingly, lately, there has been developed a wall material in which a photocatalyst having a function of decomposing harmful substances with the irradiation of ultraviolet rays is added to the mortar (for example, see Japanese Patent Laid-open Publication Heill(1999)-264224).

However, although the above-mentioned conventional wall material in which the photocatalyst is added to the mortar can decompose the harmful substances due to an action of the photocatalyst and can obtain an advantageous effect that the air pollution can be prevented, in actually applying the mortar to a wall surface, skilled workers are required

and, at the same time, the installation requires a considerable labor and time and hence, there exists a possibility that a construction cost is sharply pushed up.

Inventors of the present invention have made extensive studies and have found that a tile-shaped formed article (molded article) can be manufactured by pressure-forming (press molding) a mortar to which a photocatalyst is added and it is possible to reduce labor, time and cost required for installation by using the mortar tile manufactured in such a manner as a wall material.

Further, the inventors of the present invention also have found that although the mere pressure-forming of the mortar to which the photocatalyst is added into a tile shape may overcome a drawback on the installation, the ability to decompose the harmful substances with a photocatalyst is lowered.

Upon investigating a cause which brings about the reduction of the ability of the photocatalyst to decompose the harmful substance by pressure-forming for the mortar to which the photocatalyst is added, the inventors of the present invention have found that when the mortar to which the photocatalyst is added is subjected to pressure-forming at a relatively high pressure, a surface of the mortar is made smooth and hence, the permeability which the mortar originally possesses is impaired.

Accordingly, it is an object of the present invention to provide a mortar tile which can enhance workability without

impairing the permeability which a mortar possesses and a manufacturing method thereof.

Disclosure of the Invention

The invention according to claim 1 provides a mortar tile which is characterized in that a photocatalyst is added to a mortar and, thereafter, the pressure-forming is performed at a pressure which allows the formation of open pores (through holes) in a surface of the mortar.

The invention according to claim 2 provides a mortar tile which is characterized in that a formed article is formed by adding a photocatalyst to a mortar and, thereafter, by performing the pressure-forming at a pressure which allows the formation of open pores in a surface thereof, and a photocatalyst is applied to a surface of the formed article.

The invention according to claim 3 provides a method for manufacturing a mortar tile which is characterized in that a mortar which is molded in a tile shape is manufactured by adding a photocatalyst to the mortar and, thereafter, by performing pressure-forming at a pressure which allows the formation of open pores in a surface of the mortar.

The invention according to claim 4 provides a method for manufacturing a mortar tile which is characterized in that a mortar which is molded in a tile shape is manufactured by forming a formed article in a state that a photocatalyst is added to the mortar and, thereafter, the pressure-forming is performed at a pressure which allows the formation of

open pores in a surface thereof, and a photocatalyst is applied to a surface of the formed article.

Brief Explanation of the Drawings

Fig. 1 is an explanatory view showing a vacuum forming machine.

Fig. 2 is a graph showing a result of a formaldehyde decomposing test (a mortar).

Fig. 3 is a graph showing a result of a formaldehyde decomposing test (a mortar tile).

Fig. 4 is a microscope photograph showing a surface of a mortar tile (a specimen B).

Fig. 5 is a microscope photograph showing a surface of a mortar tile (a specimen D).

BEST MODE FOR CARRYING OUT THE INVENTION

A mortar tile according to the present invention is manufactured by pressure-forming a mortar to which a photocatalyst is added and constitutes a raw material into a tile shape.

In a manufacturing method of the mortar tile, first of all, a photocatalyst is added and mixed into the mortar using a mixer.

Here, the mortar contains slaked lime as a main component and also contains an inorganic material, fiber for plastering and glue at proper ratios. The mortar may not contain fiber for plastering and glue. As the inorganic

material, calcium carbonate, barium carbonate, barium hydroxide or the like may be used. As the fiber for plastering, Manila hemp, Japanese paper, hemp palm, wooden pulp, synthetic fiber, glass fiber, or the like may be used. As the glue, a natural glue such as glue, nonglutinous rice, konyak powder, glue plant, or the like, a synthetic glue such as polyvinyl alcohol, methyl cellulose, hydroxyl ethyl cellulose, hydroxyl propyl cellulose or the like may be used.

Further, as the photocatalyst, it is possible to use a photocatalyst having various kinds of crystal structure such as an oxide semiconductor made of a titanium oxide, zinc oxide or the like, a sulfide semiconductor made of cadmium sulfide, zinc sulfide or the like.

Further, an inorganic binder which has the property to be cured by reacting with a carbonic acid or moisture in the air may be added to the mortar when necessary. Here, as the inorganic binder, a material such as the slaked lime, a dolomite, a gypsum, a magnesium hydroxide, a cement, or the like which easily reacts with carbonic acid or water in air to form a cured body is used. One material out of a group of slaked lime, dolomite, gypsum, magnesium hydroxide, cement, and the like may be singularly used for the inorganic binder. Alternatively, a mixture of two or more kind of these materials may be used. Further, water may be added to and mixed with the mortar until the mortar obtains a given moisture content.

Next, a formed article is formed by pressure-forming

the mixture of the mortar and the photocatalyst in a substantial vacuum using a forming machine. Here, the pressure for pressure-forming is set to a relatively low pressure which allows the formation of open pores in a surface of the formed article after pressure-forming.

Finally, a photocatalyst is applied to a surface of the formed article.

In this manner, according to the present invention, the mortar tile is manufactured by performing the pressure-forming after adding the photocatalyst to the mortar and hence, the present invention can reduce labor, time and cost for installation.

Further, the forming pressure at the time of pressure-forming is set to the pressure which allows the formation of open pores on the surface thereof and hence, a surface of the mortar is made smooth whereby it is possible to preliminary prevent the permeability from being impaired thus producing a formed article having the permeability. Accordingly, it is possible to prevent the reduction of the decomposing ability of harmful substances using the photocatalyst.

Particularly, the present invention can enhance the decomposing ability of the harmful substances by applying the photocatalyst to the surface of the formed article.

Further, the manufacturing method requires no heat treatment such as baking, autoclaving or the like. Accordingly, there is no possibility that the environment

is polluted with a flue gas generated by the heat treatment. The environmental pollution can also be prevented. Further, since the heat treatment is not performed, the treatment cost can be reduced.

Further, various types of formed articles may be molded depending on shapes of a mold which is used at the time of forming thus manufacturing formed articles in a broad field.

Further, when the inorganic binder having the property to be cured by reacting with a carbonic acid gas and the moisture in air is mixed into a mixed body, the surface of the formed article can be cut, ground and polished easily before natural curing. Further, even when the surface of the formed article is cut, ground or polished, the surface of the formed article is naturally cured thus ensuring the strength of the surface of the formed article.

In the pressure-forming, a vacuum forming machine shown in Fig. 1 is used. In the drawing, the vacuum forming machine 20 is configured as follows. A lower mold 22 is arranged on a lower portion of a frame 21. A hydraulic elevating cylinder 23 is arranged on an upper portion of a frame 21 in a state that a distal end of a cylinder rod 24 extends downwardly. An upper mold 25 is connected to the distal end portion of the cylinder rod 24. Upon actuation of the elevating cylinder 23, the upper mold 25 is elevated toward or lowered away from a recessed portion 26 of the lower mold 22. In the drawing, numeral 27 indicates a vacuum pump 27 which is communicably connected with the recessed

portion 26 of the lower mold 22, numeral 28 indicates a hydraulic pump 28, and numeral 29 indicates a hydraulic control panel.

First of all, the mixture of a mortar, the photocatalyst and the like which forms the raw material is filled into the recessed portion 26 of the lower mold 22.

Next, upon actuation of the vacuum pump 27, a pressurizing space which is defined by the recessed portion 26 of the lower mold 22 and the upper mold 25 is set to an approximately vacuum state of -80KPa to -100KPa, and the raw material is formed into a plate shape or a block shape by the forming machine 20. Here, it is preferable to set the pressurizing space to an approximately vacuum state of -94KPa to -100KPa.

Here, a forming pressure which is applied to the raw material by the pressure-forming is set to 15MPa to 80MPa. This is because that when the forming pressure is 15MPa or less, a strength of the formed article is lowered, while when the forming pressure is 80MPa or more, as described later, the surface of the formed article is made smooth and hence, the permeability which the mortar originally possesses is impaired. This forming pressure differs depending on the raw material to be formed and may be a pressure which allows the formation of open pores in a surface of the formed article after forming. Thus, the forming pressure is not limited to the pressure range described above.

In this manner, by performing the forming in the

approximately vacuum, substantially no air remains in the inside of the formed article thus capable of forming a formed article having a high physical strength and a favorable dimensional accuracy.

Further, when the formed article is cured by leaving the formed article in air or in the carbon dioxide gas atmosphere after pressure-forming, slaked lime or the like which is contained in the formed article absorbs the carbonic acid gas and forms carbonic calcium and hence, it is possible to further increase the physical strength of the formed article.

Further, different from the brick, tile or the like, the heat treatment such as baking, autoclaving or the like is not applied to the formed article. Accordingly, even when an inorganic porous material, clay, a functional inorganic catalyst, an antimicrobial and antifungal agent are applied to the mixed body, there exists no possibility that these inorganic porous material, clay and the like is influenced by heat and hence, it is possible to form the molded product which holds characteristics which the respective materials such as the inorganic porous materials, clay and the like possess.

Further, since the heat treatment is not applied to the molded product, the decoloration attributed to an unexpected change in a kiln is not generated and hence, molded products having the color equal to the mixed body before pressure-forming can be produced on a mass production basis

with sufficient reproducibility.

Further, different from cement products, the raw material is not prepared in a slurry state and hence, efflorescence is not generated whereby it is possible to allow the formed article to sufficiently develop color by merely mixing 5 parts by weight or less of pigment in the mixed body.

Further, it is possible to reinforce the bending strength of the formed article by mixing fibers in the formed article.

Hereinafter, a decomposition effect of formaldehyde obtained by the combination of mortar and the photocatalyst is explained in conjunction with Fig. 2 and Fig. 3.

Here, a decomposition test is performed such that the formaldehyde having the concentration of 1000ppb is continuously supplied to a room in which mortar or mortar tiles is applied to an inner wall surface, and when a given time elapses after starting the supply of formaldehyde, ultraviolet rays are irradiated to the inner wall surface, wherein the concentration of the formaldehyde is time-sequentially measured while setting a point of time that the irradiation of light is started as the reference (0 minute).

Fig. 2 shows a result of a test when the mortar is applied to the wall surface in the same manner as the conventional method without forming the mortar in a tile pattern.

In Fig. 2, a specimen 1 is obtained by applying only the mortar, a specimen 2 is obtained by applying the mortar in which the photocatalyst is added, a specimen 3 is obtained by applying the mortar in which the photocatalyst is added and, thereafter, making a surface of the mortar into a rough surface using a wooden trowel, and a specimen 4 is obtained by coating the mortar in which the photocatalyst is added and, thereafter, by further applying the photocatalyst to a surface of the mortar.

As can be understood from Fig. 2, in all specimens 1 to 4, formaldehyde is absorbed in the mortar within a short time after the supply of formaldehyde and hence, the concentration of the formaldehyde is decreased.

However, an absorption strength of the mortar is gradually decreased along with a laps of time and hence, the concentration of the formaldehyde is gradually increased.

Then, as a matter of course, due to the irradiation of light, in the specimens 2 to 4 which contain the photocatalyst, formaldehyde is decomposed by the photocatalyst and hence, the concentration of formaldehyde is decreased.

Particularly, with respect to the specimen 4, it is possible to remarkably decrease the concentration of formaldehyde to 20ppb or less.

On the other hand, Fig. 3 shows a result of a test when the mortar tiles are applied to a wall surface.

In Fig. 3, a specimen A is obtained by applying mortar tiles which are produced by pressure-forming using only the mortar as a raw material, specimen B is obtained by applying mortar tiles which are produced by pressure-forming at a forming pressure of 100MPa using mortar to which photocatalyst is added as a raw material, a specimen C is obtained by applying mortar tiles which are produced by pressure-forming at a forming pressure of 30MPa using mortar to which photocatalyst is added as a raw material, and a specimen D is obtained by applying mortar tiles which are produced by pressure-forming at a forming pressure of 30MPa using mortar to which photocatalyst is applied as a raw material and, thereafter, by applying photocatalyst to a surface of the mortar tiles.

As can be understood from Fig. 3, in all specimens A to D, formaldehyde is absorbed in the mortar tile within a short time after the supply of formaldehyde and hence, the concentration of the formaldehyde is decreased.

However, an absorption strength of the mortar is gradually decreased along with a laps of time and hence, the concentration of the formaldehyde is gradually increased.

Then, as a matter of course, due to the irradiation of light, in the specimens B to D which contain the photocatalyst, formaldehyde is decomposed by the photocatalyst and hence, the concentration of formaldehyde is decreased.

Further, with respect to the specimen C and specimen D, it is possible to decrease the concentration of formaldehyde to 100ppb or less along with laps of time.

Particularly, with respect to the specimen D, it is possible to remarkably decrease the concentration of formaldehyde to approximately 20ppb or less.

Here, to compare the specimen B and specimens C, D which differ in the lowering of the concentration of formaldehyde after the irradiation of light, it is understood that these specimens differ in the pressure at the time of performing the pressure-forming.

Accordingly, when inventors of the present invention studied in detail the difference between the specimen B and the specimen C, as shown in Fig. 4 and Fig. 5, it is found that the specimen B and specimen C completely differ from each other with respect to the configuration of surfaces thereof.

That is, Fig. 4 is a microscope photograph of 5000 magnifications of the surface of the specimen B. As can be understood from Fig. 4, when the pressure-forming is performed at the forming pressure of 100MPa, the surface is made smooth and no open pores are not found at all thus impairing the permeability.

On the other hand, Fig. 5 is a microscope photograph of 5000 magnifications of the surface of the specimen C. As can be understood from Fig. 5, when the pressure-forming is performed at the forming pressure of 30MPa, open pores

are formed on the surface and hence the permeability is not impaired.

In this manner, based on the comparison between the specimen B and the specimen C, by adopting the pressure which allows the formation of open pores on the surface at the time of performing the pressure-forming, it is possible to prevent in advance the situation that the surface of the formed article is made smooth thus impairing the permeability whereby it is possible to produce the formed article having the permeability. Accordingly, it is possible to prevent the decomposition ability of harmful substances due to the photocatalyst from being lowered.

Further, based on the comparison between the specimen D and the specimen 4, it is found that by applying the photoresist to the surfaces of the mortar tiles, it is possible to obtain the decomposition ability of contamination substances which is compatible to the decomposition ability which is obtained when the photocatalyst is applied to the surface of the mortar to which the photoresist is added.

Industrial Applicability

The present invention can achieve advantageous effects described below.

That is, according to the present invention, the mortar tiles are manufactured such that the photocatalyst is added to the mortar and, thereafter, the pressure-forming is performed at the pressure which allows the formation of the

open pores on the surface and hence, it is possible to reduce labor, time and cost required for installation without decreasing the decomposition ability of harmful substances using the photocatalyst.

Particularly, by applying the photocatalyst to the surface, it is possible to enhance the decomposition ability of the harmful substances.